Patent Claims

53) An ultra high vacuum (UHV) compatible lead-through, comprising:
a housing;
a first space within said housing and connected via a first port to a space outside the UHV-compatible lead through;
a second space within said housing and connected via a second port to a closed system containing a polarized gas; a movable component separating the first space from the second space via an intermediate space; and seals for limiting a penetration of volatile media from said first space into said second space.

54) Ultra high vacuum (UHV)compatible lead through according to claim 53, characterized in that said intermediate space comprises a pumping connection.

55) Ultra high vacuum (UHV)compatible lead through according to claim 53,
characterized in that said moveable components within said housing are pistons of compressors or tappet rods of pistons or of valves.

56) Ultra high vacuum (UHV)compatible lead through according to claim 53
characterized in that said UHV compatible lead through serves as an outlet valve such that the valve is tightened via an adjunct tappet which is coupled with a certain free play of movement to a tappet according to claim 55 such that
in case of said tappet being placed in an intermediate position, said adjunct tappet will tighten said valve only by an overpressure on the side of the outlet of said valve

in case of said tappet being moved into its forward position, said adjunct tappet will close said valve by force, independently of the pressure conditions.

in case of said tappet being moved into the rear position, said adjunct tappet will open said valve by force, independently of pressure conditions.

57) Ultra high vacuum (UHV) compatible lead through according to claim 53,

characterized in that said intermediate space has a sufficient extension such that the stroke of said piston or of said tappet of said device is always shorter then the extension of said intermediate space in the direction of movement.

58) Assembly of Ultra high vacuum (UHV) compatible lead through according to claim 53,

characterized in that said assembly comprises several of said moveable components, placed next to each other in such a way that said intermediate spaces which belong to said moveable components are connected to each other in a conductive manner.

59) Ultra high vacuum (UHV) compatible lead through according to claim 53,

characterized in that said intermediate space is sealed by gaskets fixed in notches around the said piston or the said tappet or the surrounding cylinder.

60) Ultra high vacuum (UHV) compatible lead through according to claim 53,

characterized in that all of its parts which are in direct contact with the polarized ^{3}He comprise nonmagnetic or weakly magnetic materials having low outgassing rates.

61) Ultra high vacuum (UHV) compatible lead through according to claim 53,
characterized in that the components which are moved at/ or exposed to mechanical wear and tear comprise little outgassing titanium or bronze.

62) Ultra high vacuum (UHV) compatible lead through according to claim 53,
characterized in that said UHV-compatible lead through is a compressor, designed in a way that the dead volume in the cylinder head is minimized when the piston is in the forward position.

63) Ultra high vacuum (UHV) compatible lead through according to claim 62,
characterized in that said piston of said compressor or said tappet or said valve are driven by a hydraulic gear.

64) Ultra high vacuum (UHV) compatible lead through according to claim 63,
characterized in that said hydraulic gear of said piston comprises two pressurized chambers inside of said piston.

65) Ultra high vacuum (UHV) compatible lead through according to claim 63,
characterized in that the gear of said compressor comprises a fast running crankshaft with conrod.

66) Device for the production of nuclear spin polarized fluids comprising:
an assembly for optical pumping in a low pressure plasma,
a compressor assembly for compressing the polarized medium and a storage volume,

wherein
said compressor assembly comprises at least one ultra high vacuum (UHV) compatible lead through according to claim 53

67) Device according to claim 66,
characterized in that the valves of said device for producing polarized media comprise ultra high vacuum (UHV) compatible lead through according to claim 53

68) Device according to claim 67,
characterized in that several valves of said device for producing polarized media are gathered into valve blocs.

69) Device according to claim 68,
characterized in that said valve blocs comprise an intermediate vacuum common for a number of valves and that the intermediate vacua are connected to each other via bores.

70) Device according to claim 69,
characterized in that one or several of said valve blocs comprise the inlet valve from said optical pumping assembly to said compressor assembly and / or the outlet valve from said compressor assembly into said storage volume.

71) Device according to claim 69,
characterized in that one or several of said valve blocs comprise the valves for evacuating said optical pumping assembly and / or for controlling the gas flows,
and the pressure monitors.

72) Device according to claim 67,

characterized in that the pipeline system of the device for gas transport and evacuation comprises little outgassing aluminum tubes, tightend by metal rings.

73) Device according to claim 67,
characterized in that said device comprises ahead or after said optical pumping assembly (seen in the direction of flow) selectively absorbing getters.

74) Device according to claim 73,
characterized in that said getters comprise nonferromagnetic getter substances.

75) Device according to claim 73,
characterized in that said getters are evaporation getters.

76) Device according to claim 74,
characterized in that said getter substances comprise little relaxing titanium.

77) Device according to claim 75,
characterized in fact that said getter substances comprise Bismuth.

78) Device according to claim 75,
characterized in that said optical pumping assembly comprises itself one or several of said evaporation getters.

79) Device according to claim 78,
characterized in that said evaporation getter is part of said optical pumping assembly and is operated as a cathode in the plasma region of said optical pumping assembly in order to bind other gases fast and selectively.

80) Device according to claim 75, characterized in that said evaporation getters comprise cooling set-ups.

81) Device according to one of the claim 67, characterized in that said device is designed such that the dead volume within

- said cylinder head,
- said outlet valve of said compressor assembly to said storage volume and
- said pipelines to said storage volume

are being minimized in order to enable a fast and almost complete gas transport from said compressor assembly to said storage volume.

82) Device according to claim 81, characterized in that the stroke volume of said compressor is designed in such a way that the fraction of the gas which remains in the dead volume and relaxes therein is being minimized.

83) Device according to claim 67, characterized in that said compressor assembly comprises a compressor cylinder and that the ratio of the circumference of the said compressor cylinder to the stroke volume of said compressor is smaller than $1/(30cm^2)$, preferably smaller than $1/(100cm^2)$, and most preferably smaller than $1/(300\ cm^2)$.

84) Device according to claims 67, characterized in that said optical pumping set-up comprises at least one long cell containing the optically pumped low pressure plasma.

85) Device according to claim 84,
characterized in that said cell comprises mirrors which serve to double the absorption path length of the pumping light within said cell, thereby conserving the degree of circular polarization.

86) Device according to claim 85,
characterized in said mirrors are designed as being transparent for certain spectral lines of ^3He.

87) Device according to claim 67,
characterized in that the light source of said optical pumping assembly features a spectral distribution which is adapted to the Doppler-width of the absorption line of the noble gas.

88) Device according to claim 87,
characterized in that said light source is a laser light source and that for a given laser power the cross section of the laser beam is designed in such a manner that the resulting light intensity will not surpass the saturation value of maximum optical pumping rate.

89) Device according to claim 84 ,
characterized in that said optical pumping assembly comprises imaging optical elements being arranged outside said optical pumping cells in order to focus the beam from the light source such that the cross section of said beam remains everywhere smaller than the cross section of the cell in order to prevent for instance depolarizing reflection from the cell walls.

90) Device according to claim 84,

characterized in that at least the entrance and the outlet windows of said low pressure cells are made of glass of optical quality.

91) Device according to claim 90, characterized in that an element for determining the degree of circular polarization of light is provided and that said degree of circular polarization is determined by taking the difference of a maximum and a minimum measured voltage value and dividing it by their sum, these measurements being performed by passing the light first through a λ / 4 retardation plate followed by a liquid crystal element and finally a linear polarizer before it generates in a photo detector one or the other of said voltage values depending on a positive or negative voltage signal applied to the liquid crystal element which reacts on said positive or negative voltage signal by forming a bi-refringent optical delay plate featuring delays of either an even or an odd multiple of half of the wave length λ / 2 or vice versa.

92) Device according to claim 87, characterized in that said element for determining the degree of circular polarization is being used to determine the degree of nuclear polarization of said noble gas plasma.

93) Device according to claim 66, characterized in that said optical pumping set-up comprises at least one high frequency driven electrode powering the plasma.

94) Device according to one of the claim 66, characterized in that said device comprises at least one pumping assembly to which said intermediate vacua of said elements with moveable components are being connected.

95) Device according to claim 94, characterized in that said device comprises a purification assembly for purifying the gas pumped out of said intermediate vacua with the possibility to recycle that purified gas within said device.

96) Procedure for producing nuclear spin polarized gases comprising the following steps:
Optical pumping in a low pressure plasma followed by mechanical compression of the gas and transport into a storage volume, wherein the method of fractional pumping is being applied in the compression process.

97) Procedure according claim 96, characterized in that said fractional pumping is performed by an ultra high vacuum (UHV) compatible lead through according to claim 53.

98) Procedure according to claim 96, characterized in that the production of the nuclear spin polarized gases is performed by help of a device according to claim 66.

99) Procedure according to claim 96, characterized in that said intermediate vacua are pumped actively.

100) Procedure according to claim 96, characterized in that the gas will be purified from contaminants by getter devices before and/ or during optical pumping and / or compression.

101) Procedure according to claim 100,
characterized in that said getter devices are being cooled.

102) Procedure according to claim 101,
characterized in that said getter devices are cooled down to the temperature of liquid nitrogen.

103) Procedure according to claim 96
characterized in that the compression up to a pressure smaller than 10 bar is performed with one and the same compressor device.

104) Procedure according to claim 96
characterized in that the noble gas which is being pumped out of the actively pumped vacua is being purified and recycled to the device for producing polarized noble gases.